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Insights into the healthy immigrant effect: Mortality by period of immigration and birthplace

by Edward Ng and the LHAD research team

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The Longitudinal Health and Administrative Data (LHAD) initiative is a partnership among provincial and territorial ministries of health and Statistics Canada, as well as the Canadian Institute for Health Information, the Canadian Council of Cancer Registries and the Vital Statistics Council for Canada. The objective is to ensure that key administrative data, such as those routinely collected through the health system, can be used to undertake pan-Canadian research on relationships among risk factors, socio-economic characteristics, health status measures and health care utilization. The research involves linking provincial and territorial health administrative data within themselves, and with Statistics Canada's population health survey data, the births and deaths databases, and the Canadian Cancer Registry. In addition to complementing the ongoing record linkage research in individual provinces, LHAD studies create opportunities to learn from comparisons among jurisdictions, and to facilitate larger studies for less common types of events and conditions. The LHAD Initiative is intended to establish the foundation for a Canadian record linkage program that will further the advancement of knowledge about health determinants, outcomes and their relationships.

Statistics Canada is the operational arm of the LHAD partnership. Two divisions at Statistics Canada—the Health Statistics Division (HSD) and the Health Analysis Division (HAD)—collaborate in supporting the Initiative.

HSD is responsible for ongoing administrative support including organizing Steering Committee meetings and providing secretariat services to the Initiative. It is also responsible for building and maintaining the LHAD data processing environment, securely storing and processing LHAD datasets, and producing linked analysis files for all approved studies.

HAD provides research support via the LHAD Research Team. HAD is the primary source of health research at Statistics Canada. Its mandate is to provide high quality, relevant and comprehensive information on the health status of the population and on the health care system.

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Executive summary

- According to the 2006 Census, almost 20% of the Canadian population were foreign-born.
- By 2031, the percentage is projected to reach at least 25%.
- The origins of the immigrant population are increasingly diverse.
- Studies based on age-standardized mortality rates (ASMR) have found a healthy immigrant effect, with lower overall rates among immigrants.
- A duration effect has also been observed—immigrants' mortality advantage lessened as their time in Canada increased.
- ASMRs based on the 1991 to 2001 census mortality follow-up study indicate a healthy immigrant effect and a duration effect at the national level for all-cause mortality and for circulatory diseases and cancer.
- These generalizations mask considerable heterogeneity among immigrant groups.
- ASMRs differed by world region of birth and by sex.
- At the national level, a healthy immigrant effect was observed by world region for men, but depending on the cause of death, not for women from the United States, Sub-Saharan Africa or South Asia .
- In Toronto, Montreal and Vancouver, lack of an overall healthy immigrant effect for all-cause mortality was observed for women from the United States and Sub-Saharan Africa, and for some men from these regions.
- ASMRs for people from the United Kingdom, India and China supported an overall healthy immigrant effect at the national level, however, women from India living in Toronto and Montreal and women from the United Kindom living in Vancouver had ASMRs more similar to those of Canadian-born women. ASMR levels among women from India reflected higher circulatory disease rates. In Montreal, cancer ASMRs were higher for women from China.

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Introduction

In recent years, annual immigration to Canada has totalled more than 230,000.[1] About two-thirds (69.3%) of the 1.6 million increase in the Canadian population between 2001 and 2006 was attributable to immigration. By 2006, immigrants made up one-fifth (19.8%) of the population, a percentage that is expected to reach 25% to 28% by 2031.[2]

The health and the health care needs of this large and growing share of the population are not necessarily the same as those of people born in Canada.[3,4] Earlier studies have found a "healthy immigrant effect"; specifically, immigrants' health is better than that of the Canadian-born, but it tends to decline as their years in Canada increase.[5,6] This reduction in immigrants' health advantage is apparent in self-reported general health,[7-9] chronic diseases,[10,11] disability,[12] and mental health.[13-15] However, the relationship between immigration and health is complex. It involves both pre- and post-migration factors, for which information is often lacking. Hence, comparing the health of immigrants to that of the Canadian-born population is challenging.[16]

An additional factor is the increasing diversity in immigrants' origins. Since the 1960s, the major source countries have shifted from European to non-European nations. Consequently, it is important to analyze the healthy immigrant effect by world region and by period of immigration. However, small sample sizes have meant that most studies could not be conducted at this level of detail.

A comprehensive review of analyses of the relationship between immigration and health[17] found that the relatively few studies of disease-specific mortality among immigrants compared with the Canadian population generally supported the healthy immigrant effect.[18-22] More recently, all-cause mortality in immigrants was compared with that in the Canadian-born population.[23-26] Using unlinked 1991 mortality data, Trovato[23] found evidence of a healthy immigrant effect, but could not examine associations with period of immigration, immigration class, or socio-economic factors. DesMeules et al.[26] linked a random sample of 1980 to 1990 Citizenship and Immigration Canada landing files to 1980 to 1999 mortality data for all provinces and to health care data for Ontario, Quebec and British Columbia to study mortality risks by age, sex, region of birth, immigration category and time in Canada. The results generally supported the healthy immigrant effect and its eventual loss, notwithstanding some cause-specific exceptions. Though lacking in socio-economic data, that study contained detailed information about immigration (for example, immigration status, immigration class and period of immigration). It also found higher mortality rates among refugees than among other immigrants.

The present analysis used the 1991 to 2001 census mortality follow-up study to explore associations between mortality and dimensions of immigration such as country of birth and period of immigration. An earlier analysis of the same database by Wilkins et al.[26] showed a healthy immigrant effect, but the results pertained to the total immigrant population, with the sexes combined. The objectives of the present study were to determine:

1. if immigrants tend to have better health as measured by age-standardized mortality rates (ASMRs) than does the Canadian-born population (overall healthy immigrant effect);
2. if immigrants' initial health advantage lessens over time (duration effect); and
3. how results vary for immigrant subgroups, by world regions and selected countries at the Canada level and in Toronto, Montreal and Vancouver.

The analysis was conducted separately by sex for all causes combined and for circulatory diseases and cancer. To simplify the presentation, the disease-specific results are included in the appendix.

Data sources, definitions and methods

The 1991 to 2001 Canadian census mortality follow-up study is a probabilistically linked cohort consisting of a 15% sample (n = 2,735,152) of the non-institutionalized population aged 25 or older, all of whom were enumerated via the 1991 census long-form questionnaire. This cohort was tracked for mortality from June 4, 1991 through December 31, 2001. Because names were not captured on the census database, but were needed to link to the mortality data, creation of the cohort required two probabilistic linkages. First, eligible census respondents were linked to a nominal list (name) file (abstracted from 1990 and 1991 tax-filer data and then encrypted) using common variables such as date of birth, postal code, and spousal date of birth (if applicable); 80% of eligible respondents were successfully matched. Then, the census plus encrypted names were matched to the Canadian Mortality Database. Based on 1991 deaths, which could be identified independently in the Canadian Mortality Database and/or the name file, ascertainment of deaths in the cohort followed for mortality was estimated to be 97% overall. Specifically, more than 260,000 deaths over the 10.6-year follow-up period were linked to the sample.[26]

The 1991 Census defined immigrants as people who were, or who had been, landed immigrants in Canada. A landed immigrant is not a Canadian citizen by birth, but has been granted the right to live in Canada permanently by Canadian immigration authorities. In this study, the Canadian-born population (non-immigrants) is the reference group. The analysis excluded refugee claimants and non-permanent residents, that is, people on employment or student authorizations.

To examine the duration aspect of the healthy immigrant effect, immigrants were classified by period of immigration and by world region of birth. The period-of-immigration categories were: before 1970 (established), 1970 through 1980 (medium-term), and 1981 through June 1991 (recent). The world regions were defined as: United States, Caribbean/Central and South America, Western Europe, Eastern Europe, Sub-Saharan Africa, North Africa/Middle East/West Asia, South Asia, South East Asia, East Asia, and Oceania (Appendix Table A). These are non-standard 1991 Census classifications of place of birth, established in order to achieve a balance between creating homogeneous categories for epidemiological research and having a manageable number of groups. For example, for conciseness, South, Central, West and East Africa were combined, whereas North Africa, West Asia and the Middle East were grouped because the people in these regions share cultural and epidemiological characteristics. South Asia, South East Asia and East Asia were categorized separately according to the 1991 Census definition, except that Singapore, which is part of South East Asia in the census definition, was included in East Asia because of socio-economic and cultural similarity. For Europe, the standard 1991 Census groupings of West, South and North Europe were combined with the Scandinavian countries as Western Europe, except that Albania and Yugoslavia, which are part of South Europe in the census definition, were included with Eastern Europe. South and Central America (including Mexico) and the Caribbean were combined. The United States of America was singled out as a place of birth instead of being part of North America. Greenland and St. Pierre and Miquelon, the other two components of North America, were included with Oceania. However, Oceania was dropped from the analyses by world region of birth because of the small sample size (n=4,600).

The immigrant population can be very diverse, even within the same world region of birth. To make the results more specific, immigrants from three countries—China (including Hong Kong), India and the United Kingdom—were selected for more in-depth analysis. Since the 1980s, the People's Republic of China and India have become the leading sources of immigrants to Canada, whereas the United Kingdom was a major source of immigrants in earlier years. Because the baseline data were obtained in 1991, before the influx of immigrants from the People's Republic, those in the sample who were born there most likely lived in Hong Kong before migrating to Canada. For this analysis, the People's Republic of China and Hong Kong were grouped.

This study also examines mortality in the three gateway Census Metropolitan Areas (CMA): Toronto, Montreal and Vancouver. For these analyses, the reference group was the Canadian-born population in each CMA.

Age- and sex- specific mortality rates by 5-year age group (at baseline) were used to derive the age-standardized mortality rate (ASMRs), using the population structure of the census mortality follow-up cohort as the standard. ASMRs and rate ratios were calculated by sex and by key immigration characteristics overall and for circulatory diseases (ICD9 codes 390 to 459) and cancer (ICD9 codes 140 to 239), which are the top two causes of death in Canada.[27] ASMRs were calculated at the national level by sex for:

1. total population
2. Canadian-born population (reference)
3. total immigrant population and by period of immigration.
4. immigrant population by world region of birth and then by period of immigration.
5. immigrant population for selected countries of birth

These calculations were done separately for all-cause and for cause-specific mortality. The steps were repeated for the selected CMAs, except for period of immigration, which was not always possible because of small sample sizes. Rate ratios were calculated to determine if the ASMRs for various immigrant subgroups were significantly different from those for the respective Canadian-born population—the overall healthy immigrant effect. The duration effect was determined based on whether a lessening of immigrants' health advantage was observed, as reflected in rising ASMRs with increased years in Canada as indicated by period of immigration.

Data were suppressed according to Statistics Canada's data quality guidelines. The coefficient of variation was used to ensure that the ASMR estimates could be released; estimates with a coefficient of variation larger than 33.3% were suppressed.

Findings

Descriptive results

The total 1991 to 2001 Canadian census mortality follow-up cohort numbered 2.7 million individuals who had been aged 25 or older in 1991; 552,300 or 20% were immigrants (Appendix Table B). Western Europe (comprising North, South and West Europe) was the top region of origin (close to 50%), followed by Eastern Europe (13%), the Caribbean/ Central and South America (8%), and East Asia (8%). The majority (56%) were established immigrants who had arrived in Canada before 1971; 23% came between 1971 and 1981, and 21% were more recent immigrants who had arrived in the 1981-to-1991 period. The 1991 Census showed that those from Europe and the United States were most likely to be established immigrants, while those from Asia and Africa were more likely to be recent immigrants. For example, more than 70% of European immigrants had arrived before 1971, whereas the figure for immigrants from South Asia was 8%.

In 1991, close to one immigrant adult in five (19%) was aged 65 or older, compared with 15% of Canadian-born adults. Moreover, the percentage of seniors varied by area of origin, reflecting periods of immigration; for example, 36% of Eastern European-born immigrants were seniors, compared with 5% of those who came from Sub-Saharan Africa.

In 1991, more than half (54%) of immigrants lived in Toronto, Montreal or Vancouver, whereas 25% of Canadian-born adults lived in these three cities. As well, the percentages varied by birthplace: 27% of those from the United States lived in these three CMAs, compared with 75% from East Asia.

Analytical results

Overall

For the adult population of Canada overall, the age-standardized mortality rates (ASMRs) per 100,000 person-years at risk were 1,230 for men and 703 for women (Figure 1). The immigrant population had significantly lower ASMRs than did Canadian-born adults: 1,006 versus 1,305 for men, and 610 versus 731 for women.

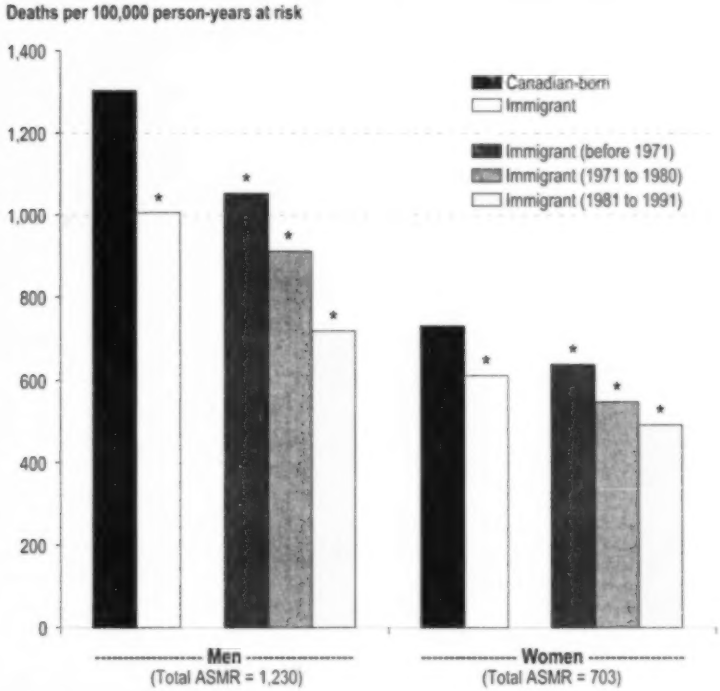
A rise in ASMRs as years in Canada increased reflects the loss of immigrants' health advantage over time. AMSRs among immigrant men were 720, 913 and 1,054 for the recent, medium-term and established cohorts, respectively. Among immigrant women, the corresponding rates were 491, 546 and 637. Even so, these rates were all significantly below those of the Canadian-born population.

A healthy immigrant effect was also evident for two major causes of death: circulatory diseases and cancer (Appendix Table C).

World region

ASMRs varied widely depending on the immigrants' birthplace (Table 1). Among men, ASMRs ranged from 668 (South Asia) to 1,112 (United States); among women, the range was from 439 (South East Asia) to 699 (United States). Despite these wide variations, the ASMRs of immigrants (especially men) from each world region were significantly lower than those of Canadian-born adults. The only exceptions were women from the United States and from Sub-Saharan Africa whose ASMRs were similar to that of Canadian-born

Figure 1
Age-standardized mortality rates (ASMRs) for immigrants, by sex and period of immigration, compared with Canadian-born cohort members, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001



* significantly different from Canadian-born population
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table 1
Deaths and crude and age-standardized mortality rates per 100,000 person-years at risk for immigrants, by sex, world region of birth and period of immigration, compared with Canadian-born cohort members, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

	Men					Women				
		Mortality rate					Mortality rate			
				95% confidence interval					95% confidence interval	
	Deaths	Crude	Age-standardized	from	to	Deaths	Crude	Age-standardized	from	to
Canadian-born	**120,185**	**1,122**	**1,305**	**1,297**	**1,312**	**84,181**	**752**	**731**	**726**	**736**
Immigrants (total)	**33,006**	**1,184**	**1,006***	**996**	**1,018**	**22,694**	**819**	**610***	**602**	**618**
United States	**2,197**	**1,635**	**1,112***	**1,064**	**1,161**	**2,249**	**1,251**	**699**	**666**	**733**
Before 1971	1,724	2,357	1,104*	1,048	1,163	1,846	1,944	729	687	773
1971 to 1980	353	849	1,110*	996	1,237	267	486	636*	559	724
1981 to 1991	120	610	953*	786	1,156	136	456	739	614	889
Caribbean/Central and South America	**936**	**429**	**825†***	**764**	**892**	**766**	**287**	**487†***	**451**	**525**
Before 1971	378	707	893*	791	1,008	311	473	552*	488	625
1971 to 1980	352	384	817*	716	933	295	263	475*	419	538
1981 to 1991	206	282	750*	632	890	160	180	409*	344	487
Western Europe	**18,869**	**1,405**	**1,055†***	**1,040**	**1,071**	**12,957**	**1,017**	**642†***	**630**	**653**
Before 1971	17,328	1,656	1,070*	1,052	1,087	11,778	1,198	649*	636	662
1971 to 1980	1,144	550	1,056*	989	1,127	814	404	587*	545	632
1981 to 1991	397	449	898*	811	995	365	408	573*	513	639
Eastern Europe	**7,445**	**2,124**	**1,048†***	**1,023**	**1,075**	**4,358**	**1,361**	**605†***	**585**	**626**
Before 1971	6,991	2,887	1,062*	1,028	1,097	3,994	1,875	609*	582	637
1971 to 1980	262	722	954*	837	1,087	216	555	573*	499	658
1981 to 1991	192	267	862*	719	1,034	148	217	533*	447	636
Sub-Saharan Africa	**253**	**373**	**903***	**776**	**1,051**	**177**	**298**	**640**	**543**	**755**
Before 1971	68	701	825*	636	1,071	61	696	677	518	883
1971 to 1980	124	420	990*	786	1,247	79	281	636	488	828
1981 to 1991	61	213	992	655	1,503	37	164	600	411	877
North Africa/Middle East/West Asia	**577**	**482**	**813†***	**744**	**888**	**305**	**337**	**512***	**456**	**575**
Before 1971	319	958	937*	833	1,054	159	593	538*	458	632
1971 to 1980	147	479	825*	694	979	99	423	579*	474	709
1981 to 1991	111	199	556*	439	704	47	117	395*	274	569
South Asia	**631**	**420**	**668†***	**611**	**730**	**360**	**278**	**550***	**490**	**616**
Before 1971	218	699	861*	721	1,028	123	559	579*	478	701
1971 to 1980	246	414	703*	611	810	140	248	603	480	758
1981 to 1991	167	279	509*	424	611	97	191	517*	401	666
South East Asia	**550**	**348**	**669***	**609**	**735**	**444**	**237**	**439†***	**395**	**488**
Before 1971	62	598	606*	455	808	78	469	530*	409	688
1971 to 1980	257	358	792*	661	948	184	250	432*	366	508
1981 to 1991	231	304	627*	541	726	182	187	419*	350	502
East Asia	**1,406**	**631**	**794†***	**751**	**838**	**974**	**408**	**470†***	**441**	**500**
Before 1971	517	1,084	952*	864	1,049	366	794	501*	449	560
1971 to 1980	484	676	819*	747	898	344	442	486*	437	542
1981 to 1991	405	391	636*	565	715	264	229	402*	352	460

† support for duration effect
* significantly different from Canadian-born population
Note : Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

women. For these groups, ASMRs were higher, regardless of period of immigration. For example, the ASMR among female immigrants from the United States who had arrived in the 1981-to-1991 period, was 739, compared with 731 for Canadian-born women.

The world regions exhibiting the effect of duration in Canada were:

- for both sexes – the Caribbean/Central and South America, Western Europe, Eastern Europe and East Asia;
- for men – North Africa/Middle East/West Asia and South Asia; and
- for women – South East Asia.

On the other hand, for some world regions, ASMRs were lower among established immigrants than among immigrants who arrived more recently. For instance, men who had immigrated from Sub-Saharan Africa before 1971 had a lower ASMR (825) than did Canadian-born men (1,305), while those who immigrated after 1980 had a higher ASMR (992).

Circulatory disease and cancer ASMRs generally support the overall healthy immigrant effect. However, ASMRs for circulatory disease among women from South Asia, Sub-Saharan Africa and the United States did not differ significantly from the figure for Canadian-born women (Appendix Table D). And women from the United States were the only group whose cancer ASMR was not significantly lower than that of Canadian-born women (Appendix Table E).

Census Metropolitan Area (CMA)

Overall, ASMRs in the three main destination Census Metropolitan Areas—Toronto, Montreal and Vancouver—support the healthy immigrant effect. For instance, the ASMR for immigrant men in Toronto was 974, significantly below the ASMR (1,280) for Canadian-born men in that CMA; the corresponding figures for women were 589 and 775 (Table 2).

ASMRs at the CMA level are strongly influenced by immigrants' place of birth. In 1991, at least 40% of the immigrants in each of the three CMAs were from Western Europe. Consequently, the overall immigrant ASMRs in these CMAs were closer to the levels experienced by Western European immigrants than, for example, to the levels among immigrants from Asia, who were less numerous.

The absence of a healthy immigrant effect among women from the United States and from Sub-Saharan Africa was apparent at the CMA level, although small numbers for the Sub-Saharan group limit the ability to detect an effect. As well, the healthy immigrant effect was not observed among men from the United States in these three CMAs. Nor was it observed among men from Sub-Saharan Africa in Vancouver. However, in Toronto, where close to half of Sub-Saharan African immigrants resided, their ASMRs were relatively low.

In the three CMAs, circulatory disease ASMRs among women from Sub-Saharan Africa and from South Asia did not differ significantly from those of Canadian-born women; and among women from the United States, this was the case not only for circulatory disease, but also for cancer (Appendix Tables F and G). Moreover, some groups, while demonstrating an overall healthy immigrant effect, had elevated disease-specific ASMRs, especially when CMA-level data were examined. For example, women from Western and Eastern Europe and men from Eastern Europe living in Vancouver and men from the United States in all three CMAs had circulatory disease ASMRs that did not differ significantly from those of Canadian-born residents of these CMAS.

China, India and the United Kingdom

China (including Hong Kong) and India have been leading source countries since the 1980s; the United Kingdom had been a major source country in earlier years. A healthy immigrant effect was apparent among immigrants from each of these birthplaces (data not shown). Among men, at the national level, ASMRs were 690 for those from India, 810 for those from China, and 1,105 for those from the United Kingdom; this compared with 1,305 among Canadian-born men. Among women, the ASMRs were 537 (India), 471 (China), 695 (United Kingdom) and 731 (Canadian-born).

At the CMA level, ASMRs for immigrants from each of the three countries were generally lower than those for the Canadian-born (Table 3). The exceptions were women from India living in Toronto (634) and Montreal (503) and women from the United Kingdom in Vancouver (700), whose ASMRs did not differ significantly from those of Canadian-born women.

The elevated ASMR among women from India at the CMA level largely reflected a high circulatory disease ASMR (Appendix Table H). In Vancouver, the relatively high ASMR among women from the United Kingdom was partially due to high ASMRs for circulatory disease (289) and for cancer (281). Immigrants from China almost always had lower ASMRs, compared with those of the Canadian-born population in each CMA. However, in Montreal, the cancer ASMR among women from China (209) was similar to that of Canadian-born women (252).

Table 2
Deaths and crude and age-standardized mortality rates per 100,000 person-years at risk for immigrants, by sex and world region of birth, compared with Canadian-born cohort members, non-institutional population aged 25 or older at baseline, Toronto, Montreal and Vancouver, 1991 to 2001

	Men					Women				
		Mortality rate					Mortality rate			
				95% confidence interval					95% confidence interval	
	Deaths	Crude	Age-standardized	from	to	Deaths	Crude	Age-standardized	from	to
Canadian-born										
Toronto	9,072	1,014	1,280	1,253	1,308	7,616	771	775	757	792
Montreal	13,678	1,151	1,393	1,369	1,417	10,315	771	680	667	694
Vancouver	5,168	1,103	1,233	1,199	1,268	4,009	792	731	708	754
Immigrants (total)										
Toronto	8,383	940	974*	953	996	5,650	617	589*	574	605
Montreal	3,338	1,006	929*	897	962	1,872	589	463*	442	485
Vancouver	3,151	1,069	982*	948	1,017	2,450	806	613*	588	639
United States										
Toronto	199	1,087	1,129	978	1,304	198	821	671	579	778
Montreal	144	1,871	1,262	1,050	1,517	134	1,355	617	501	760
Vancouver	157	1,342	1,109	944	1,302	195	1,303	719	603	858
Caribbean/Central and South America										
Toronto	468	443	869*	770	980	412	305	546*	487	613
Montreal	182	445	842*	712	996	140	267	386*	324	460
Vancouver	28	318	611*	404	925	28	268	396*	260	602
Western Europe										
Toronto	4,645	1,191	1,062*	1,031	1,095	3,133	822	633*	610	656
Montreal	1,684	1,101	958*	910	1,008	882	644	476*	444	509
Vancouver	1,755	1,592	1,080*	1,029	1,134	1,394	1,294	676*	638	716
Eastern Europe										
Toronto	1,939	1,763	1,014*	967	1,063	1,139	1,059	587*	552	625
Montreal	819	2,532	934*	863	1,010	441	1,364	458*	409	513
Vancouver	398	1,605	1,016*	916	1,126	265	1,246	629*	552	716
Sub-Saharan Africa										
Toronto	79	285	881*	620	1,254	63	249	674	425	1,069
Montreal	15	F	F	F	F	7	F	F	F	F
Vancouver	51	558	1,135	807	1,596	33	377	810	480	1,366
North Africa/Middle East/West Asia										
Toronto	116	368	698*	567	860	70	285	586*	450	762
Montreal	318	636	872*	777	978	146	368	447*	379	527
Vancouver	14	249	364*	209	635	8	F	F	F	F
South Asia										
Toronto	252	390	784*	641	958	150	274	626	500	783
Montreal	32	288	422*	279	637	17	206	455	273	759
Vancouver	117	467	752*	574	986	62	265	523*	393	695
South East Asia										
Toronto	166	318	593*	500	705	141	219	432*	355	526
Montreal	73	380	765*	577	1,016	59	266	475*	356	634
Vancouver	98	423	701*	568	865	74	255	470*	365	605
East Asia										
Toronto	506	569	775*	707	850	334	350	459*	412	512
Montreal	62	583	756*	525	1,088	40	362	363*	265	498
Vancouver	477	720	829*	756	909	358	483	499*	449	554

* significantly different from Canadian-born population

F too unreliable to be published

Note : Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table 3
Deaths and crude and age-standardized mortality rates per 100,000 person-years at risk for immigrants from China (including Hong Kong), India or United Kingdom, by sex, compared with Canadian-born cohort members, non-institutional population aged 25 or older at baseline, Toronto, Montreal and Vancouver, 1991 to 2001

	Men					Women				
		Mortality rate					Mortality rate			
				95% confidence interval					95% confidence interval	
	Deaths	Crude	Age-standardized	from	to	Deaths	Crude	Age-standardized	from	to
Canadian-born										
Toronto	9,072	1,014	1,280	1,253	1,308	7,616	771	775	757	792
Montreal	13,678	1,151	1,393	1,369	1,417	10,315	771	680	667	694
Vancouver	5,168	1,103	1,233	1,199	1,268	4,009	792	731	708	754
Immigrants (total)										
Toronto	8,383	940	974*	953	996	5,650	617	589*	574	605
Montreal	3,338	1,006	929*	897	962	1,872	589	463*	442	485
Vancouver	3,151	1,069	982*	948	1,017	2,450	806	613*	588	639
China (including Hong Kong)										
Toronto	442	598	790*	717	871	283	365	460*	408	517
Montreal	55	644	765*	529	1,106	37	422	373*	268	518
Vancouver	425	766	854*	773	942	314	515	502*	449	561
India										
Toronto	198	433	796*	647	980	121	311	634	502	802
Montreal	23	359	437*	267	717	14	276	503	287	884
Vancouver	112	472	779*	595	1,019	56	252	515*	383	693
United Kingdom										
Toronto	1,926	1,644	1,146*	1,094	1,200	1,705	1,309	700*	664	737
Montreal	242	1,867	1,019*	890	1,166	263	1,772	580*	501	671
Vancouver	970	1,820	1,083*	1,014	1,157	941	1,601	700	650	754

* significantly different from Canadian-born population at Census Metropolitan Area level
Note: Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Discussion

The 1991 to 2001 census mortality follow-up study permits analysis of the healthy immigrant effect—the dominant hypothesis in immigrant health research—by world region of birth and for different areas of Canada. This hypothesis suggests that immigrants arrive with better health than the Canadian-born population, but that this health advantage tends to disappear over time. The results of this study provide overall support for this trend. However, similar to earlier research,[24,25] the analysis of ASMRs by world region of origin, period of immigration and residence reveals underlying differences that may not be evident when only the overall results are examined.

For example, the study found that female immigrants from South Asia tended to have high ASMRs for circulatory disease. This result confirms previous research that found high circulatory disease mortality rates among South Asians in Asian and non-Asian countries,[28] although results had been mixed for first-generation immigrants from these areas and resident in Canada. A study based on Canadian mortality data from the 1960s to the 1980s, which did not reveal an elevated risk for circulatory disease, reasoned that because of the immigration system's selection criteria pertaining to health status, South Asian immigrants might not be fully representative of the South Asian population in general.[22] Nonetheless, a more recent study based on mortality data from 1979 to 1993 found high circulatory disease mortality among South Asians of both sexes in Canada.[20]

Heterogeneity in ASMRs within immigrant subgroups living in Vancouver, Toronto and Montreal was also evident in this study. For example, men born in Eastern Europe and resident in Vancouver were found to have relatively high circulatory disease ASMRs, but their counterparts in Toronto and Montreal did not. This result highlights the importance of conducting country-specific and disease-specific research at the the CMA level.

Limitations

Overall, while this analysis provides support for the duration aspect of the healthy immigrant effect, the findings did not hold for immigrants from all world regions. Factors such as pre-migration socio-economic conditions and age at immigration may influence post-immigration mortality among the various cohorts. Also, immigration category (economic, family or refugee) may be an important determinant of post-immigration health outcomes; however, such data are not available from the 1991 to 2001 census mortality follow-up study.

This analysis has several other limitations. First, even with such a large database, sample size becomes a problem when world region of birth data are cross-classified by place of residence and period of immigration. As well, immigration patterns differ by CMA. For instance, Haitians tend to settle in Montreal; thus, studies of this group are likely to focus on only one CMA.

A second possible limitation is differential attrition in the census mortality follow-up study. If immigrants are more likely than the Canadian-born to move out of the country, it might partially explain the healthy immigrant effect that emerged in this analysis. However, while the possibility of immigrants moving out of the country exists, it is most common among younger people. Mortality rates at younger ages tend to be low, so such attrition should not have a noticeable impact on the results.

Third, the study is limited by the lack of information about risk factors, such as physical activity, body mass index, nutrition, smoking, and alcohol consumption. Such information is usually collected by health surveys which have small samples that restrict the ability to conduct country-specific analysis of the healthy immigrant effect.

Future directions

As the 1991 to 2001 census mortality follow-up study shows, even after 20 or more years in the country, immigrants from most world regions had lower ASMRs than did the Canadian-born population. Areas for further research include an examination of socio-economic determinants that may play a role in immigrant adaption and contribute to the healthy immigrant effect, including the initial medical assessments conducted at point of entry to Canada.[29] Further study of immigrants' mortality risk could involve the use of multivariate analysis to examine factors such as occupation, education and knowledge of official languages. As well, greater study of differences in the experience of various immigrant groups would be an important area of continued research. Future studies could also examine specific cancers (lung, colorectal, breast, etc.) and circulatory diseases (ischemic heart disease, cerebrovascular disease, etc.). Because this database contains other causes of death, analysis could also be conducted for causes such as diabetes and intentional and unintentional injuries.

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Appendix

Table A
Countries, by world region

World region	Countries
United States	United States of America
Caribbean/Central and South America	Anguilla, Antigua, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, St. Christopher and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay, Venezuela, Virgin Islands (British), Virgin Islands (U.S.)
Western Europe	Andorra, Austria, Belgium, Cyprus, Denmark, Federated Republic of Germany, Finland, France, Gibraltar, Greece, Iceland, Italy, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, Republic of Ireland (Eire), San Marino, Spain, Sweden, Switzerland, United Kingdom, Vatican City State
Eastern Europe	Albania, Bulgaria, Czech and Slovak Federal Republic, Hungary, Poland, Romania, U.S.S.R., Yugoslavia
Sub-Saharan Africa	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde Islands, Central African Republic, Chad, Comoros, Congo, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Mozambique, Namibia, Niger, Nigeria, Republic of Djibouti, Republic of South Africa, Rwanda, Réunion, Sao Tomé and Principe, Senegal, Seychelles, Sierra Leone, Somali Democratic Republic, St. Helena and Ascension, Swaziland, Tanzania, Togo, Uganda, Zaire, Zambia, Zimbabwe
North Africa/Middle East/West Asia	Afghanistan, Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Republic of Yemen, Saudi Arabia, Sudan, Syria, Tunisia, Turkey, United Arab Emirates, Western Sahara
South Asia	Bangladesh, Bhutan, India, Nepal, Pakistan, Republic of Maldives, Sri Lanka
South East Asia	Brunei, Indonesia, Kampuchea, Laos, Malaysia, Philippines, Thailand, Union of Myanmar, Viet Nam
East Asia	Hong Kong, Japan, Macao, Mongolia, North Korea, People's Republic of China, Taiwan, Singapore, South Korea
Oceania	American Samoa, Australia, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Greenland, Guam (U.S.), Kiribati, Marshall Islands, Nauru, New Caledonia, New Zealand, Papua New Guinea, Pitcairn Island, Republic of Belau, Solomon Islands, St. Pierre and Miquelon, Tonga, Tuvalu, U.S. Pacific Trust Territories, Vanuatu, Wallis and Futuna, Western Samoa, Other

Table B
Selected characteristics of Canadian-born and immigrant cohort members, by world region of birth, non-institutional population aged 25 or older, Canada, 1991

		Immigrant									
	Canadian-born	Total	United States	Caribbean/ Central and South America	Western Europe	Eastern Europe	Sub-Saharan Africa	North Africa/ Middle East/ West Asia	South Asia	South East Asia	East Asia
Total number	**2,167,500**	**552,300**	**31,900**	**46,700**	**262,700**	**69,000**	**12,200**	**20,300**	**26,900**	**33,100**	**44,800**
	Percentage										
Sex											
Male	49	51	43	45	52	53	53	57	54	46	49
Female	51	49	57	55	48	47	47	43	46	54	51
Age group											
25 to 44	57	44	46	63	35	29	66	61	62	70	58
45 to 64	28	37	30	32	44	35	29	31	31	24	31
65 or older	15	19	24	6	22	36	5	8	7	6	11
Period of immigration											
Before 1971	...	56	55	25	78	70	15	29	19	8	21
1971 to 1980	...	23	30	42	15	11	45	26	41	42	32
1981 to 1991	...	21	15	33	7	19	40	45	39	50	47
Residence											
Census Metropolitan Area - Montreal, Toronto, Vancouver	25	54	28	73	48	48	64	74	67	61	75
Other Census Metropolitan Area	30	28	29	20	29	35	28	22	22	32	20
Census Agglomeration	18	9	17	4	12	9	5	3	9	5	3
Rural	28	8	26	4	11	8	3	1	3	2	1

... not applicable
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table C
Circulatory disease and cancer deaths and crude and age-standardized mortality rates per 100,000 person-years at risk for immigrants, by sex and period of immigration, compared with Canadian-born cohort members, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

	Men					Women				
		Mortality rate					Mortality rate			
				95% confidence interval					95% confidence interval	
	Deaths	Crude	Age-standardized	from	to	Deaths	Crude	Age-standardized	from	to
Circulatory disease (total)	**56,628**	**420**	**463**	**459**	**467**	**39,797**	**285**	**252**	**250**	**255**
Canadian-born	**44,121**	**412**	**492**	**487**	**497**	**30,829**	**276**	**259**	**256**	**262**
Immigrant	**12,507**	**449**	**382†***	**375**	**389**	**8,968**	**324**	**228†***	**223**	**233**
Before 1971	10,657	685	399*	391	407	7,643	514	236†*	230	241
1971 to 1980	1,199	185	352*	332	374	840	124	201†*	187	215
1981 to 1991	651	112	275*	253	300	485	80	183†*	167	201
Cancer (total)	**50,357**	**373**	**390**	**387**	**394**	**35,219**	**252**	**244**	**242**	**247**
Canadian-born	**39,170**	**366**	**410**	**406**	**414**	**28,090**	**251**	**255**	**252**	**258**
Immigrant	**11,187**	**401**	**333†***	**326**	**339**	**7,129**	**257**	**209†***	**204**	**214**
Before 1971	9,368	602	350*	343	358	5,700	383	222*	215	228
1971 to 1980	1,179	182	288*	271	307	897	133	181*	169	194
1981 to 1991	640	110	225*	207	246	532	87	160*	146	176

† support for duration effect
* significantly different from Canadian-born population
Note : Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table D
Circulatory disease deaths and crude and age-standardized mortality rates per 100,000 person-years at risk for immigrants, by sex, world region of birth and period of immigration, compared with Canadian-born cohort members, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

	Men					Women				
		Mortality rate					Mortality rate			
				95% confidence interval					95% confidence interval	
	Deaths	Crude	Age-standardized	from	to	Deaths	Crude	Age-standardized	from	to
Canadian-born	**44,121**	**412**	**492**	**487**	**497**	**30,829**	**276**	**259**	**256**	**262**
Immigrants (total)	**12,507**	**449**	**382***	**375**	**389**	**8,968**	**324**	**228***	**223**	**233**
United States	**904**	**673**	**441***	**412**	**472**	**966**	**537**	**249**	**231**	**268**
Before 1971	721	986	444*	410	481	825	869	262	240	286
1971 to 1980	140	337	472	398	561	86	157	194*	154	243
1981 to 1991	43	219	392	286	537	55	184	278	208	371
Caribbean/Central and South America	**299**	**137**	**280***	**244**	**320**	**234**	**88**	**175†***	**153**	**200**
Before 1971	113	211	257*	206	320	86	131	179*	143	224
1971 to 1980	118	129	294*	235	369	94	84	176*	143	218
1981 to 1991	68	93	317*	240	420	54	61	158*	118	212
Western Europe	**6,978**	**520**	**391***	**381**	**400**	**4,995**	**392**	**230***	**223**	**237**
Before 1971	6,440	616	395*	385	405	4,590	467	233*	226	240
1971 to 1980	398	191	412*	370	459	258	128	198*	174	225
1981 to 1991	140	158	339*	286	402	147	164	230	194	272
Eastern Europe	**3,042**	**868**	**406***	**391**	**422**	**1,922**	**600**	**239†***	**228**	**251**
Before 1971	2,892	1,194	416*	398	434	1,810	850	244*	232	257
1971 to 1980	89	245	363*	292	451	79	203	212	169	265
1981 to 1991	61	85	365	272	490	33	48	139*	98	198
Sub-Saharan Africa	**93**	**137**	**359***	**282**	**457**	**61**	**103**	**273**	**209**	**357**
Before 1971	25	258	307*	202	468	24	274	256	166	395
1971 to 1980	46	156	441	310	626	27	96	284	186	432
1981 to 1991	22	77	359	188	687	10	F	F	F	F
North Africa/Middle East/West Asia	**248**	**207**	**364†***	**318**	**415**	**118**	**130**	**215***	**179**	**258**
Before 1971	143	430	433	363	517	64	239	217	169	278
1971 to 1980	56	182	327*	247	431	43	184	269	199	364
1981 to 1991	49	88	243*	176	334	11	F	F	F	F
South Asia	**274**	**182**	**319†***	**271**	**355**	**157**	**121**	**272**	**229**	**322**
Before 1971	95	305	383	292	501	54	245	270	203	360
1971 to 1980	108	182	332*	269	409	61	108	332	231	478
1981 to 1991	71	119	247*	185	329	42	83	269	183	397
South East Asia	**185**	**117**	**251***	**214**	**294**	**164**	**88**	**191***	**161**	**226**
Before 1971	19	183	174*	106	285	33	198	267	182	392
1971 to 1980	82	114	274*	217	347	65	88	169*	131	218
1981 to 1991	84	111	257*	202	327	66	68	178*	133	239
East Asia	**441**	**198**	**266†***	**241**	**293**	**321**	**134**	**159†***	**142**	**177**
Before 1971	183	384	372*	317	436	141	306	185*	155	222
1971 to 1980	149	208	251*	213	296	114	147	163*	135	196
1981 to 1991	109	105	190*	151	238	66	57	122*	93	159

† support for duration effect
* significantly different from Canadian-born population
F too unreliable to be published
Note : Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table E
Cancer deaths and crude and age-standardized mortality rates per 100,000 person-years at risk for immigrants, by sex, world region of birth and period of immigration, compared with Canadian-born cohort members, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

	Men					Women				
		Mortality rate					Mortality rate			
				95% confidence interval					95% confidence interval	
	Deaths	Crude	Age-standardized	from	to	Deaths	Crude	Age-standardized	from	to
Canadian-born	**39,170**	**366**	**410**	**406**	**414**	**28,090**	**251**	**255**	**252**	**258**
Immigrants (total)	**11,187**	**401**	**333***	**326**	**339**	**7,129**	**257**	**209***	**204**	**214**
United States	**624**	**464**	**332***	**306**	**360**	**610**	**339**	**253**	**232**	**276**
Before 1971	471	644	319*	290	352	480	505	268	241	298
1971 to 1980	112	270	338	279	409	91	166	235	188	293
1981 to 1991	41	208	294	211	408	39	131	253	180	356
Caribbean/Central and South America	**308**	**141**	**256†***	**223**	**293**	**302**	**113**	**163†***	**144**	**184**
Before 1971	143	267	313*	256	382	133	202	193*	159	235
1971 to 1980	107	117	239*	188	304	108	96	146*	118	181
1981 to 1991	58	80	209*	156	281	61	69	142*	108	188
Western Europe	**6,654**	**496**	**359†***	**350**	**368**	**4,115**	**323**	**226†***	**219**	**233**
Before 1971	6,101	583	363*	354	373	3,702	377	228*	220	237
1971 to 1980	418	201	344*	308	385	300	149	204*	181	231
1981 to 1991	135	153	296*	248	353	113	126	193*	159	235
Eastern Europe	**2,393**	**683**	**347†***	**332**	**362**	**1,269**	**396**	**210***	**197**	**223**
Before 1971	2,221	917	350*	329	371	1,115	524	206*	189	225
1971 to 1980	104	286	327*	265	404	79	203	208	165	262
1981 to 1991	68	95	276*	204	374	75	110	253	197	326
Sub-Saharan Africa	**83**	**122**	**266***	**203**	**349**	**58**	**98**	**158***	**118**	**211**
Before 1971	28	289	335	221	507	19	217	219	137	350
1971 to 1980	42	142	243*	158	374	29	103	157*	99	247
1981 to 1991	13	F	F	F	F	10	F	F	F	F
North Africa/Middle East/West Asia	**168**	**140**	**218†***	**185**	**257**	**102**	**113**	**144†***	**118**	**177**
Before 1971	98	294	268*	217	330	51	190	169*	126	225
1971 to 1980	47	153	253*	187	342	31	133	158*	110	228
1981 to 1991	23	41	91*	55	148	20	50	113*	63	202
South Asia	**138**	**92**	**134†***	**111**	**162**	**104**	**80**	**124***	**100**	**153**
Before 1971	53	170	186*	135	258	38	173	153*	107	217
1971 to 1980	49	83	133*	97	184	37	66	116*	81	167
1981 to 1991	36	60	109*	76	157	29	57	116*	73	182
South East Asia	**212**	**134**	**229†***	**197**	**267**	**170**	**91**	**130***	**110**	**155**
Before 1971	30	289	294	193	446	27	162	135*	83	218
1971 to 1980	101	141	251*	200	315	82	111	155*	121	199
1981 to 1991	81	107	211*	164	271	61	63	115*	86	153
East Asia	**556**	**250**	**284***	**260**	**309**	**360**	**151**	**167***	**150**	**185**
Before 1971	190	399	295*	251	348	103	223	154*	125	190
1971 to 1980	187	261	306*	264	355	137	176	189*	159	225
1981 to 1991	179	173	249*	210	294	120	104	149*	123	181

† support for duration effect
* significantly different from Canadian-born population
F too unreliable to be published
Note : Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table F
Circulatory disease deaths and crude and age-standardized mortality rates per 100,000 person-years at risk for immigrants, by sex and world region of birth, compared with Canadian-born cohort members, non-institutional population aged 25 or older at baseline, Toronto, Montreal and Vancouver, 1991 to 2001

	Men					Women				
		Mortality rate					Mortality rate			
	Deaths	Crude	Age-standardized	95% confidence interval from	to	Deaths	Crude	Age-standardized	95% confidence interval from	to
Canadian-born										
Toronto	3,165	354	463	446	480	2,597	263	257	247	267
Montreal	4,841	407	509	495	525	3,680	275	231	224	239
Vancouver	1,862	398	451	431	473	1,454	287	256	243	269
Immigrant										
Toronto	2,988	335	354*	341	367	2,004	219	209*	200	218
Montreal	1,177	355	334*	315	354	674	212	160*	148	173
Vancouver	1,220	414	382*	361	404	992	326	232*	217	247
United States										
Toronto	66	360	387	301	496	74	307	224	176	285
Montreal	62	806	485	370	636	51	516	169	123	232
Vancouver	61	521	416	322	539	86	575	238	181	313
Caribbean/Central and South America										
Toronto	145	137	289*	237	352	126	93	193*	159	234
Montreal	54	132	248*	182	338	35	67	104*	73	147
Vancouver	12	136	258	139	480	7	F	F	F	F
Western Europe										
Toronto	1,668	428	388*	369	408	1,085	285	212*	199	225
Montreal	528	345	319*	291	349	319	233	165*	147	185
Vancouver	673	611	409*	378	442	585	543	250	228	273
Eastern Europe										
Toronto	731	665	363*	337	391	453	421	211*	192	232
Montreal	348	1,076	378*	336	424	169	523	152*	129	180
Vancouver	174	702	430	369	501	111	522	245	201	298
Sub-Saharan Africa										
Toronto	27	97	269	153	473	12	F	F	F	F
Montreal	4	F	F	F	F	F	F	F	F	F
Vancouver	21	230	524	312	880	17	F	F	F	F
North Africa/Middle East/West Asia										
Toronto	52	165	327*	241	444	27	110	256	168	391
Montreal	133	266	366*	307	437	56	141	179	138	234
Vancouver	5	F	F	F	F	4	F	F	F	F
South Asia										
Toronto	111	172	400	283	566	60	110	304	206	448
Montreal	10	F	F	F	F	8	F	F	F	F
Vancouver	53	212	431	280	663	28	120	289	191	436
South East Asia										
Toronto	56	107	236*	177	314	64	100	218	165	289
Montreal	21	109	254*	154	417	21	95	200	129	312
Vancouver	32	138	247*	172	355	20	69	152*	94	243
East Asia										
Toronto	127	143	203*	169	244	100	105	145*	119	176
Montreal	16	151	159*	92	276	12	109	110*	62	196
Vancouver	171	258	312*	268	364	120	162	166*	139	199

* significantly different from Canadian-born population
F too unreliable to be published
Note : Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table G
Cancer deaths and crude and age-standardized mortality rate per 100,000 person-years at risk for immigrants, by sex and world region of birth, compared with Canadian-born cohort members, non-institutional population aged 25 or older at baseline, Toronto, Montreal and Vancouver, 1991 to 2001

	Men					Women				
		Mortality rate					Mortality rate			
	Deaths	Crude	Age-standardized	95% confidence interval from	to	Deaths	Crude	Age-standardized	95% confidence interval from	to
Canadian-born										
Toronto	2,916	326	395	381	410	2,591	262	274	263	285
Montreal	4,727	398	459	445	472	3,569	267	252	244	261
Vancouver	1,533	327	360	342	379	1,343	265	256	243	271
Immigrant										
Toronto	2,942	330	321*	309	333	1,971	215	204*	195	214
Montreal	1,222	368	326*	307	345	624	196	165*	152	178
Vancouver	1,062	360	321*	302	341	741	244	206*	192	222
United States										
Toronto	73	399	370	292	468	66	274	254	198	326
Montreal	40	520	390	276	552	41	415	285	201	404
Vancouver	46	393	334	248	449	50	334	278	203	380
Caribbean/Central and South America										
Toronto	157	149	260*	213	317	166	123	181*	151	217
Montreal	53	130	256*	188	347	57	109	144*	109	189
Vancouver	7	F	F	F	F	13	125	177	93	339
Western Europe										
Toronto	1,673	429	353*	336	371	1,093	287	227*	213	241
Montreal	691	452	355*	328	385	296	216	168*	149	189
Vancouver	600	544	364	335	395	397	369	235	211	261
Eastern Europe										
Toronto	655	595	348*	321	377	380	353	220*	197	246
Montreal	256	792	336*	291	389	136	421	173*	141	213
Vancouver	131	528	325	273	387	70	329	196*	152	252
Sub-Saharan Africa										
Toronto	22	79	143*	83	249	22	87	137*	84	223
Montreal	7	F	F	F	F	3	F	F	F	F
Vancouver	17	186	305	165	566	9	F	F	F	F
North Africa/Middle East/West Asiav										
Toronto	32	102	159*	106	237	26	106	164*	108	249
Montreal	96	192	252*	205	311	44	111	123*	91	165
Vancouver	F	F	F	F	F	F	F	F	F	F
South Asia										
Toronto	59	91	141*	105	190	44	81	126*	91	174
Montreal	12	F	F*	F	F	F	F	F	F	F
Vancouver	21	84	119*	75	187	22	94	145*	90	234
South East Asia										
Toronto	63	121	193*	146	256	47	73	108*	77	150
Montreal	30	156	247*	169	360	21	95	114*	73	180
Vancouver	37	160	255	182	358	35	121	186	129	270
East Asia										
Toronto	205	231	289*	250	334	123	129	153*	128	183
Montreal	32	301	277*	189	407	21	190	189	122	292
Vancouver	182	275	287*	247	334	138	186	191*	162	227

* significantly different from Canadian-born population
F too unreliable to be published
Note : Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table H
Circulatory disease and cancer deaths and crude and age-standardized mortality rates per 100,000 person-years at risk for immigrants from China (including Hong Kong), India or United Kingdom, by sex, compared with Canadian-born cohort members, non-institutional population aged 25 or older at baseline, Toronto, Montreal and Vancouver, 1991 to 2001

	Men					Women				
		Mortality rate					Mortality rate			
	Deaths	Crude	Age-standardized	95% confidence interval from	to	Deaths	Crude	Age-standardized	95% confidence interval from	to
Circulatory disease										
Canadian-born										
Toronto	3,165	354	463	446	480	2,597	263	257	247	267
Montreal	4,841	407	509	495	525	3,680	275	231	224	239
Vancouver	1,862	398	451	431	473	1,454	287	256	243	269
Immigrant										
Toronto	2,988	335	354*	341	367	2,004	219	209*	200	218
Montreal	1,177	355	334*	315	354	674	212	160*	148	173
Vancouver	1,220	414	382*	361	404	992	326	232*	217	247
China (including Hong Kong)										
Toronto	111	150	203*	167	246	84	108	143*	115	177
Montreal	15	176	168*	95	295	11	125	107*	58	196
Vancouver	160	289	340*	289	400	108	177	172*	142	208
India										
Toronto	90	197	418	296	590	48	123	306	205	457
Montreal	8	F	F	F	F	6	F	F	F	F
Vancouver	50	211	446	291	683	26	117	289	189	440
United Kingdom										
Toronto	698	596	407*	377	439	633	486	226*	208	246
Montreal	82	633	326*	261	406	114	768	213	171	266
Vancouver	362	679	394*	354	439	411	700	259	232	289
Cancer										
Canadian-born										
Toronto	2,916	326	395	381	410	2,591	262	274	263	285
Montreal	4,727	398	459	445	472	3,569	267	252	244	261
Vancouver	1,533	327	360	342	379	1,343	265	256	243	271
Immigrant										
Toronto	2,942	330	321*	309	333	1,971	215	204*	195	214
Montreal	1,222	368	326*	307	345	624	196	165*	152	178
Vancouver	1,062	360	321*	302	341	741	244	206*	192	222
China (including Hong Kong)										
Toronto	183	248	305*	263	355	104	134	155*	128	189
Montreal	27	316	275*	182	416	20	228	209	134	325
Vancouver	158	285	288*	245	339	122	200	195*	163	233
India										
Toronto	45	99	135*	97	189	34	87	124*	86	179
Montreal	6	F	F	F	F	F	F	F	F	F
Vancouver	21	89	128*	82	202	19	86	140*	84	232
United Kingdom										
Toronto	645	551	382	353	414	515	395	250	228	275
Montreal	81	625	361	289	451	71	478	224	172	291
Vancouver	324	608	373	334	417	246	419	244	212	281

* significantly different from Canadian-born population
F too unreliable to be published
Note : Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.